(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
5 July 2001 (05.07.2001)

PCT

(10) International Publication Number
WO 01/47803 A1

(51) International Patent Classification[7]: C01B 13/10, B01J 19/08, H01T 23/00, F02M 27/00, A45D 19/16

(21) International Application Number: PCT/US00/35401

(22) International Filing Date:
22 December 2000 (22.12.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/173,075 24 December 1999 (24.12.1999) US

(71) Applicant and
(72) Inventor: LEE, Jim, L. [US/US]; 5430 Commerce Blvd., Rohnert Park, CA 94928 (US).

(74) Agents: JOHNSON, Larry, D. et al.; Johnson & Stainbrook, LLP, Suite 203, 3550 Round Barn Boulevard, Santa Rosa, CA 95403 (US).

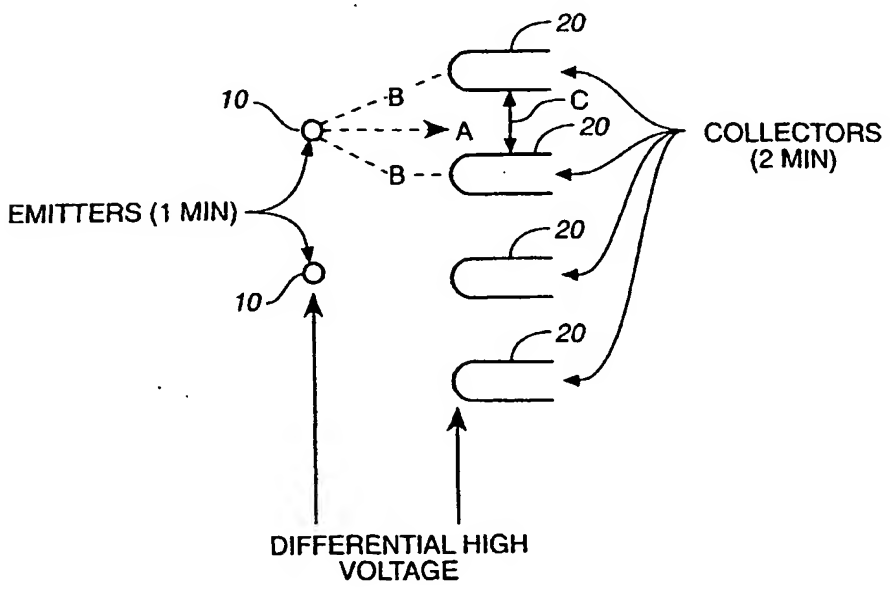
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *With international search report.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: METHOD AND APPARATUS TO REDUCE OZONE PRODUCTION IN ION WIND DEVICES



(57) Abstract: A method to limit ozone production in wind ion devices while simultaneously realizing incidents of high acceleration in such devices varies the high voltage potential across the array of emitter(s) (10) and collectors (20) over time in such a manner as to generate a wave effect of airflow. The variance may be achieved by switching, ramping, or gating the high voltage potential delivered to the array.

WO 01/47803 A1

production.

Disclosure of Invention

Ion wind devices accelerate gas ions by applying differential high voltage electric fields between one or more emitters and a plurality of collectors (accelerators). The inventive method limits ozone production while simultaneously realizing incidents of high acceleration in such devices by varying the high voltage potential across the array of emitter(s) and collectors over time in such a manner as to generate a "wave effect" of airflow. Several alternative methods of varying the high voltage potential have proven successful in accomplishing this wave effect. One method, which may be referred to as a switching method, allows the positive emitter high voltage potential to operate at a reduced level (e.g., + 6 KV) for a period of time (e.g., three seconds), and then switch to a higher potential (e.g., +8.5 KV) for another, and preferably shorter period of time (e.g., one second). The result is that at the lower (less ozone generating level) airflow is simultaneously reduced. However, when switched from the lower to the higher potential for one second higher airflow is momentarily achieved due to accelerated ion momentum. The overall average airflow is slightly higher than the linear three to time ratio due to ion momentum transfer and resulting inertia from it.

An alternative method, which may be referred to as a ramping method, accomplishes the wave effect by use of an electronic circuit to generate a nonlinear sawtooth ramp driving voltage. Typical ramp duration would also be, e.g., four seconds, with the ending portion and trailing edge effecting the highest voltage state for approximately one second. In both the switching method and ramping method airflow velocities were varied typically from a low state of 300 feet per minute to a high state of 500 feet per minute. Subsequent ozone production levels varied from a low of 17ppb for 3 seconds to a high of 50ppb for less than one second. Overall average ozone production was less than 25 ppb. This represents an improvement over operating the same array at a steady state of 350 feet per minute and generating an average of 35 ppb ozone. Furthermore, the burst of 500 feet per minute of airflow improves perceptible operation of the ion wind device.

A further alternate method which also produces the wave effect may be referred to as a gate method, which is a gate voltage which switches either (or both) the positive high voltage to the emitter or the negative high voltage to the collector at timed intervals, such as

Fig. 2 is a schematic view of the switching method of this invention. This method provides a pulsed high voltage to the emitter/collector array, i.e., a high voltage excitation configuration to drive the array by switching from a lower-level positive high voltage state HV1 to a higher-level positive high voltage state HV2 at pre-determined time intervals, e.g., one second HV1 and three seconds HV2. It is not necessary to include the negative voltage reference -HV if the positive voltage is increased proportionally to achieve like airflow levels. Also, the voltage polarities may be reversed with minimal effect upon the airflow levels.

Fig. 3 is a schematic view of the ramping method of this invention. This method provides a ramped high voltage to the emitter/collector array, i.e., a high voltage excitation configuration to drive the array with a voltage ramp, which changes in amplitude over a variable time interval. The low-level high voltage on time state may typically be as long as 5.5 seconds for minimal ozone production. Conversely, the low-level high voltage may be as short as 2.5 seconds for maximum desired ozone. The ramp up time is typically 1.5 seconds to create a differential voltage in excess of 14,000 volts. Actual time and amplitude may be varied for effect depending upon desired airflow and ozone levels.

Fig. 4 is a schematic view of the gate method of this invention. This method provides a sequential high voltage to the emitter/collector array, i.e., a high voltage gating (or switching on/off) method whereby the differential high voltage applied to the array is turned from a zero state to a maximum high state at pre-determined intervals. The on/off timed states and differential amplitude may be varied for effect. For example, a 20-second on to 20 second off time and a differential high voltage level of 15,000 volts would be the maximum duty cycle and amplitude for airflow and ozone output. As in the switching and ramping methods, supra, it is not absolutely necessary to use a negative high voltage on the collector array if the voltage level is increased proportionally on the emitter array, since the airflow and ozone levels will change proportionally in like ambient conditions. However, a negative voltage applied to the collector array is usually used to improve contaminant collection, limit circuit cost and minimize corona arcing to neutral components located in the vicinity of the array housing.

9. The method of reducing ozone production in ion wind devices of claim 1 wherein said step of varying said high voltage potential over time comprises providing a gating voltage to said emitter/collector array.

10. The method of reducing ozone production in ion wind devices of claim 9 wherein said gating voltage is turned from a zero state to a maximum high state at predetermined time intervals.

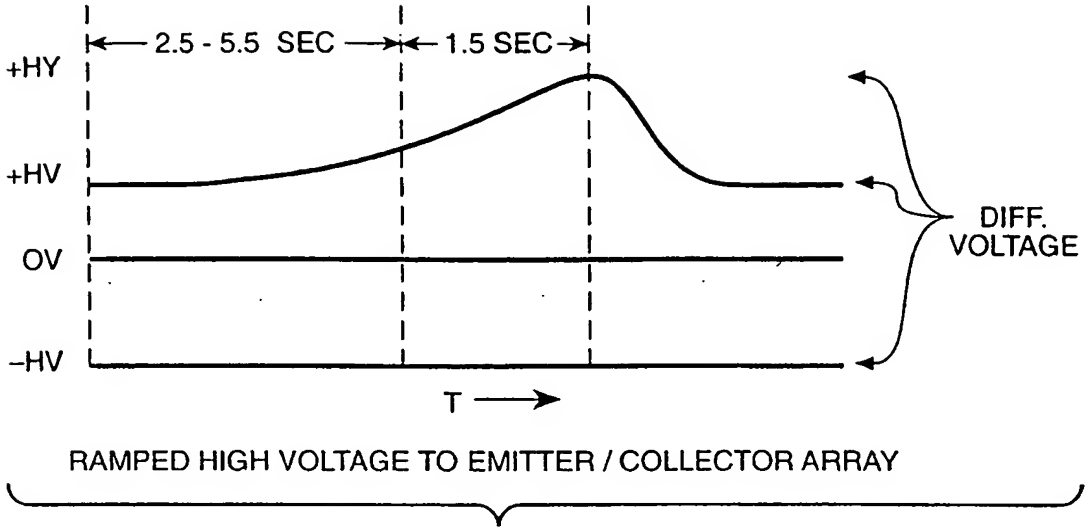

2.5 - 5.5 SEC
1.5 SEC
+HY
+HV
OV
-HV
T
DIFF. VOLTAGE
RAMPED HIGH VOLTAGE TO EMITTER / COLLECTOR ARRAY

FIG._3

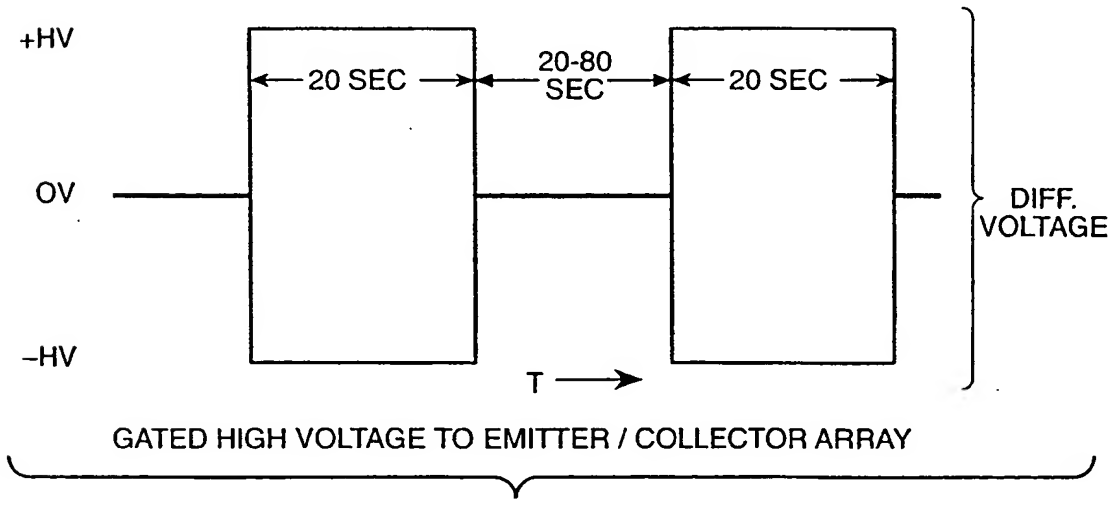

+HV
OV
-HV
20 SEC
20-80 SEC
20 SEC
T
DIFF. VOLTAGE
GATED HIGH VOLTAGE TO EMITTER / COLLECTOR ARRAY

FIG._4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/35401

A. CLASSIFICATION OF SUBJECT MATTER:
US CL. :

132/116, 154, 272, 112, 116, 148, 152, 271. 272; 204/176; 422/186.07; 361/226, 230, 232; 123/539, 272; 15/104.002, 246.3, 344, 345, 39.5, 40

B. FIELDS SEARCHED
Minimum documentation searched
Classification System: U.S.

132/116, 154, 272, 112, 116, 148, 152, 271. 272; 204/176; 422/186.07; 361/226, 230, 232; 123/539, 272; 15/104.002, 246.3, 344, 345, 39.5, 40